METHOD FOR CREATING A FIBROUS SUBSTANCE SUSPENSION USED FOR PRODUCING A TISSUE WEB OR HYGIENE WEB

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a U.S. National Stage of International Patent Application No. PCT/EP2004/050027 filed January 20, 2004, and claims priority under 35 U.S.C. § 119 of German Patent Application No. 10302783.1 filed January 24, 2003.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates to a method for creating a fibrous suspension used for producing a tissue web or a hygiene web. It further relates to tissue products made from a fibrous suspension produced according to such a method.

2. Discussion of Background Information

[0003] The production of tissue requires large amounts of water, determined by the extremely low consistency or stock consistency of the fibrous suspension to be fed to the relevant paper or tissue machine. In addition, tissue is produced with a very low basis weight between 8 and 40 g/m^2, depending on the respective final product, such as, e.g., cellulose wadding (8 to 30 g/m^2), hygiene tissue (14 to 25 g/m^2), hygiene paper (8 to 30 g/m^2), napkin paper (20 to 30 g/m^2) and towel paper (20 to 40 g/m^2).

[0004] Furthermore, these products have a low beating degree, which is necessary to ensure an adequate dewatering and drying of the web to be produced. However, as is generally known, the beating makes a major contribution to the mechanical properties of the final product. As a result, the low

beating degree often conflicts with the requirements regarding mechanical properties.

[0005] In most cases, tissue products are produced from a bleached sulfite or sulfate fibrous suspension, sometimes mixed with bleached wood pulp and/or recovered fibrous paper stock (e.g., wet broke, broke, recovered paper, etc.) and/or some type of fibrous suspension in a single-cylinder or fourdrinier Yankee machine. This applies regardless of whether the respective tissue product contains filler that was produced through a beating process or another production process. The material used with the conventional process is currently either precipitate material or another material such as calcium carbonate, talc, TiO_2, silica, etc.

[0006] In order to achieve the strongest possible bonding of the fillers to the fiber surface with a respective replacement of fibrous material by filler material, the corresponding treatment has recently been conducted through a so-called "Fiber Loading™" process, as described in U.S. Pat. No. 5,223,090. In such a "Fiber Loading™" process, at least one additive, such as, e.g., a filler, is deposited on the wetted fiber surfaces of the fibrous material. The fibers can thereby be loaded, e.g., with calcium carbonate. To this end, calcium oxide and/or calcium hydroxide is added to the moist, disintegrated fiber material in such a way that at least a part thereof combines with the water present in the fiber material. The fiber material thus treated is subsequently treated with carbon dioxide.

[0007] As described in U.S. Pat. No. 6 413 365 B1 and DE 101 07 448 A, a disperger is used that can also be used at the same time as a reactor for the chemical precipitation reaction.

SUMMARY OF THE INVENTION

[0008] The present invention discloses a method of creating a fibrous suspension with which the efficiency and cost-effectiveness of the production of corresponding tissue or hygiene products is further optimized.

[0009] This invention provides a method for producing a fibrous suspension used for the production of a tissue web or a hygiene web, in which method the fibers contained in the fibrous suspension are directly loaded with a filler in an online process in the tissue material preparation line through a chemical precipitation reaction.

[0010] According to the present invention, conventional fillers are replaced by a filler produced through a chemical precipitation reaction according to the "Fiber Loading™" process. Such a fibrous suspension has a higher drainability and a lower beating degree. Moreover, the fibers loaded with filler according to the present invention have a lower water retention value. The respective tissue product can be produced more cost-effectively because the water of the fibrous suspension can be removed much more quickly and the tissue web can be dried more quickly. With loading the fibers according to the "Fiber Loading™" process, higher values result in terms of drainability with the same beating degree, so that a higher beating degree can be achieved, which means better mechanical properties for the final product. The lower water retention or better drainability and better drying prove to be an advantage in particular when the respective final product is subsequently printed.

[0011] With the corresponding treatment through a "Fiber Loading™" process, crystalline precipitation product particles can be produced in the online process.

[0012] The precipitation product is preferably calcium carbonate. According to a preferred embodiment of the invention, to load the fibers of the fibrous suspension, calcium oxide and/or calcium hydroxide is added and the

precipitation is initiated through carbon dioxide or a gas containing carbon dioxide (for example, flue gas or the like). The crystalline precipitation product particles are produced in the respective gas atmosphere preferably without the introduction of mixing energy.

[0013] To load the fibers, calcium carbonate is deposited on the wetted fiber surfaces by adding calcium oxide and/or calcium hydroxide to the moist fiber material, whereby at least part thereof can combine with the water of the fibrous material. The fiber material is then treated with carbon dioxide or a gas containing carbon dioxide. The calcium carbonate ($CaCO_3$) obtained can form a suspension around and between the fibers.

[0014] The term "wetted fiber surfaces" can apply to all the wetted surfaces of the individual fibers. This includes cases in which the fibers are loaded with calcium carbonate both on their outer surface and in their interior (lumen).

[0015] Accordingly, the fibers are loaded with the filler calcium carbonate, the deposition on the wetted fiber surfaces being carried out by a so-called "Fiber Loading™" process, as described as such in U.S. 5,223,090. In this "Fiber Loading™" process, the carbon dioxide reacts with the calcium hydroxide to form water and calcium carbonate.

[0016] The fibrous suspension is preferably fed to a treatment unit comprising a fluffer, a refiner, a disperger and/or the like. The treatment unit can have, e.g., a structure such as is described in US 6,413,365 B1 and DE 101 07 448 A.

[0017] The fibers of the fibrous suspension can be loaded with filler before or after the treatment unit comprising a fluffer, a refiner, a disperger and/or the like. According to the invention, the treatment unit comprising a fluffer, a refiner,

a disperger and/or the like can be used at the same time as a reactor for the chemical precipitation reaction. In this respect, the invention can be embodied, e.g., as described in US 6,413,365 B1 and DE 101 07 448 A.

[0018] The calcium hydroxide can be added to the fibrous suspension in liquid form or in dry form.

[0019] A preferred embodiment of the method according to the invention provides that the fibrous suspension, e.g., the fibrous suspension mixed beforehand with calcium hydroxide, is fed to the treatment unit comprising a fluffer, a refiner, a disperger and/or the like with a stock consistency that lies in the range of approximately 5 to approximately 60% and preferably in a range of approximately 15 to approximately 35%.

[0020] The carbon dioxide or the gas containing carbon dioxide can be added before, after and/or into the treatment unit.

[0021] The carbon dioxide or the gas containing carbon dioxide is added at a temperature that lies in a range of approximately –15 to approximately 120°C, and preferably in a range of approximately 20 to approximately 90°C.

[0022] With the "Fiber Loading™" process, individual precipitation product particles can be produced which are deposited on or in the fibers at equal intervals. In the gas zone provided for carrying out the precipitation reaction, the separate, individual fibers can be exposed to the respective gas atmosphere, whereupon the corresponding precipitation reaction occurs and directly after that the calcium carbonate ($CaCO_3$) is obtained.

[0023] According to the invention, crystalline precipitation product particles with a rhombohedral form, a scalenohedral form and/or spherical crystalline product precipitation particles can be produced. The respective amount of

crystalline precipitation product particles depends on the respective temperature range for the fibrous suspension and the carbon dioxide and, e.g., on the proportion of calcium hydroxide in the fibrous suspension.

[0024] According to the invention, a treatment unit is used in the form of a disperger with two plates opposite to one another and rotating relative to one another, preferably in the form of a disperger with a rotor and a stator. Such a disperger can, for example, have a structure such as the disperger described in US 6,413,365 B1 and DE 101 07 448 A.

[0025] In such a treatment unit, the dimensions of the crystalline precipitation product particles can be influenced in the desired manner. For example, a desired distribution of crystalline precipitation product particles in the fibrous suspension can be achieved. Preferably, only low shearing forces are generated in the respective treatment unit.

[0026] Accordingly, when passing through the treatment unit, crystalline precipitation product particles can be produced, the maximum dimensions of which lie in a range of approximately 0.05 to approximately 5 µm and preferably in a range of approximately 0.3 to approximately 2.5 µm.

[0027] Depending on the respective type of paper, crystalline precipitation product particles with a rhombohedral form with a respective edge length in a range of approximately 0.05 to approximately 2 µm, or crystalline precipitation product particles with a scalenohedral form with a respective length in a range of approximately 0.05 to approximately 2 µm and a respective diameter in a range of approximately 0.01 to approximately 0.5 µm can be produced.

[0028] According to the invention, the fibrous suspension is diluted with water, preferably in a radially outer area of the treatment unit comprising two plates rotating relative to one another. The further radially outwards the fibrous

suspension reaches on the rotor disk, the lower the respective shear or shearing force in view of the fed dilution water.

[0029] The stock consistency of the fibrous suspension guided through the treatment unit is in a range of approximately 0.1 to approximately 50% and preferably in a range of approximately 5 to approximately 35%.

[0030] According to the invention, a constant feed of carbon dioxide or gas containing carbon dioxide is provided. The carbon dioxide or the gas containing carbon dioxide is added, e.g., under a pressure in a range of approximately 0.1 to approximately 6 bar, and preferably in a range of approximately 0.5 to approximately 3 bar.

[0031] A corresponding pressure in the carbon dioxide supply line can be provided by which the gas, i.e., the carbon dioxide or the gas containing carbon dioxide, is fed, e.g., to form a gas ring that can also be produced, e.g., in the treatment unit. As with a garden hose, the pressure is increased as a higher water quantity is required. Since the carbon dioxide is a compressible gas, the respective amount of gas can also be increased accordingly in order to ensure a complete precipitation reaction.

[0032] According to a preferred embodiment of the invention, in the course of the chemical precipitation reaction, an essentially complete conversion of the base materials (i.e., calcium oxide or calcium hydroxide and carbon dioxide) into the reaction products (i.e., calcium carbonate and water) is ensured by regulating or controlling the pH value of the fibrous suspension. This is preferably accomplished via the supply of carbon dioxide or gas containing carbon dioxide. A pH value can be established which lies in a range of approximately 6 to approximately 10, and preferably in a range of approximately 7 to approximately 8.5. Corresponding values can be provided in particular for the final reaction.

[0033] The energy introduced for the chemical precipitation reaction lies in a range of approximately 0.3 to approximately 8 kWh/t, and preferably in a range of approximately 0.5 to approximately 4 kWh/t.

[0034] Sufficient dilution water for mixing with the fibrous suspension is added so that a stock consistency of the diluted fibrous suspension results in a range of approximately 0.1 to approximately 16%, and preferably in a range of approximately 2 to approximately 6%.

[0035] The fibrous suspension can then be exposed to atmospheric pressure and fed to a following machine or it can be placed in a container or box. The fibrous suspension can then be fed, e.g., to the next process equipment that follows in the process for producing a tissue or hygiene web.

[0036] The treatment unit is preferably operated such that its rotating plate or rotor has a circumferential speed at the radially outer edge in a range of approximately 20 to approximately 100 m/s, and preferably in a range of approximately 40 to approximately 60 m/s.

[0037] The width of the gap between the two plates of the treatment unit rotating relative to one another is in a range of approximately 0.5 to approximately 100 mm, and preferably in a range of approximately 25 to approximately 75 mm.

[0038] In the treatment unit, the diameter of the two plates rotating relative to one another, or of the rotor and the stator, is in a range of approximately 0.5 to approximately 2 m.

[0039] The reaction time for the chemical precipitation reaction is in a range of approximately 0.01 min to approximately 1 min, and preferably is approximately 0.1 s to approximately 10 s.

[0040] If necessary, free calcium carbonate that is not deposited in and/or on the fibers can be washed out.

[0041] A pressure container is not necessary.

[0042] According to the invention, the following parameters affect the chemical precipitation reaction: fibrous suspension, calcium oxide and/or calcium hydroxide in liquid or dry form, carbon dioxide, gas zone, rotor, stator, crystals produced in a gas atmosphere without introducing mixing energy, mixing at low shearing force, no pressure container.

[0043] According to the invention, individual crystalline precipitation product particles can be produced which are deposited on or in the fibers at equal intervals in the manner necessary to meet the requirements of the respective tissue product. The particle sizes described above, for example, can be produced.

[0044] After the "Fiber Loading™" process has been completed, the following advantages result regarding the stock properties for the tissue product:

[0045] The fibrous suspension treated according to the "Fiber Loading™" process has a higher drainability or a lower beating degree. The respective values can lie, e.g., in a range of 5 to approximately 100 ml CSF or in a range of approximately 0.2 to approximately 15°SR, depending on the drainability or the beating degree. Furthermore, the fibers loaded accordingly have lower water retention values, which can lie, e.g., in a range from approximately 2 to approximately 25%, depending on the respective furnish. Tissue paper can ~~now~~ be produced in a more cost-effective manner, since water can be removed much more quickly from the fibrous suspension and the tissue web can be dried more quickly.

[0046] For tissue applications for which no specific filler content is necessary, the free precipitated calcium carbonate, i.e., the calcium carbonate not deposited in or on the fibers, can be removed by a washing process before the fibrous suspension is fed to the respective tissue machine or, if necessary, before the beating process. As a result, the fibers remain covered with calcium carbonate, which provides the advantage that the dewatering is facilitated and the drying accelerated, thereby resulting in a lower re-moistening of the final tissue product.

[0047] The "Fiber Loading™" process can be performed before beating, after beating or during beating, depending on the requirements of the respective final product.

[0048] Since a higher drainability results with an equal beating degree when the fibers are loaded with a precipitation product, a greater beating is possible, which leads to better mechanical properties of the final product.

[0049] Lower water retention and better drying are an advantage, in particular if the respective product is subsequently printed.

[0050] According to the invention, there is provided a method for creating a fibrous suspension for producing a tissue web or a hygiene web by directly loading fibers contained in a fibrous suspension with a filler through a chemical precipitation reaction in an online process in a tissue material preparation line.

[0051] According to the invention, the crystalline precipitation product particles are produced in the online process. The crystalline precipitation product particles comprise calcium carbonate. The maximum dimensions of the crystalline precipitation product particles are in the range of approximately 0.05 µm to approximately 5 µm, and preferably in the range of approximately 0.3 µm

to approximately 2.5 µm. The invention includes washing out free calcium carbonate not deposited on or in the fibers.

[0052] According to the invention, the loading of the fibers includes adding at least one of calcium oxide and calcium hydroxide, and the chemical precipitation reaction is initiated through carbon dioxide or a gas containing carbon dioxide. The crystalline precipitation product particles may be produced without the introduction of mixing energy. Calcium hydroxide in liquid form or in dry form may be added to the fibrous suspension. The carbon dioxide or the gas containing carbon dioxide is added at a temperature in the range of approximately -15°C to approximately 120°C, preferably in the range of approximately 20°C to approximately 90°C.

[0053] According to the invention, crystalline precipitation product particles with a rhombohedral form may be produced in the online process, the particles having an edge length of approximately 0.05 µm to approximately 2 µm. Crystalline precipitation product particles with a scalenohedral form may be produced in the online process, the particles having an edge length of approximately 0.05 µm to approximately 2 µm and a diameter of approximately 0.01 µm to approximately 0.5 µm. Spherical crystalline precipitation product particles may be produced in the online process.

[0054] The invention includes feeding the fibrous suspension to a treatment unit comprising at least one of a fluffer, refiner, and disperger. The loading of the fibers may occur before or after feeding the fibrous suspension to the treatment unit. The treatment unit is usable as a reactor for the chemical precipitation reaction.

[0055] According to the invention, the fibrous suspension has a stock consistency in the range of approximately 5% to approximately 60% during feeding, preferably in the range of approximately 15% to approximately 35%.

The invention includes adding calcium hydroxide to the suspension before the feeding of the fibrous suspension to the treatment unit.

[0056] According to the invention, the treatment unit comprises a disperger with two plates disposed opposite to one another and rotating relative to one another. The two plates comprise a rotor and stator. A radially outer edge portion of a rotating portion of the treatment unit has a circumferential speed of approximately 20 m/s to approximately 100 m/s, preferably approximately 40 m/s to approximately 60 m/s. The two plates are separated by a gap of approximately 0.5 mm to approximately 100 mm, preferably approximately 25 mm to approximately 75 mm. The two plates have a diameter of approximately 0.5 m to approximately 2 m.

[0057] According to the invention, crystalline precipitation product particles are produced in the online process and the dimensions of the crystalline precipitation product particles are influenced in the treatment unit.

[0058] The invention includes diluting the fibrous suspension with water in a radially outer area of the treatment unit.

[0059] According to the invention, the fibrous suspension guided through the treatment unit has a stock consistency of approximately 0.1% to approximately 50%, preferably approximately 5% to approximately 35%.

[0060] The invention includes maintaining a substantially constant supply of carbon dioxide or a gas containing carbon dioxide into the fibrous suspension. The invention further includes adding carbon dioxide or a gas containing carbon dioxide to the fibrous suspension at a pressure of approximately 0.1 bar to approximately 6 bar, preferably approximately 0.5 bar to approximately 3 bar.

[0061] The invention includes regulating or controlling a pH value of the fibrous suspension by regulating or controlling a supply of carbon dioxide, such that substantially all base materials of the chemical precipitation reaction are converted to reaction products. The invention further includes establishing the pH value in a range of approximately 6 to approximately 10, preferably in the range of approximately 7 to approximately 8.5. The invention further includes introducing energy for the chemical precipitation reaction in a range of approximately 0.3 kWh/t to approximately 8 kWh/t, preferably in the range of range of approximately 0.5 kWh/t to approximately 4 kWh/t.

[0062] The invention includes adding dilution water to the fibrous suspension to obtain a diluted fibrous suspension with a stock consistency of approximately 0.1% to approximately 16%, preferably approximately 2% to approximately 6%.

[0063] According to the invention, the chemical precipitation reaction has a reaction time of approximately 0.01 minute to approximately 1 minute, preferably approximately 0.1 seconds to approximately 10 seconds.

[0064] According to the invention, there is provided tissue product made from the fibrous suspension according to the disclosed method.

BRIEF DESCRIPTION OF THE DRAWINGS

[0065] Two embodiments of the invention are shown purely by way of example in a simplified diagrammatic representation in Figs. 1 and 2.

[0066] Figure 1 shows a diagrammatic representation of a first embodiment of the invention.

[0067] Figure 2 shows a diagrammatic representation of a second embodiment of the invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0068] Fig. 1 shows an exemplary embodiment in which the fibrous suspension 10 is first fed to the "Fiber Loading™" process 12 and subsequently is treated accordingly in a treatment unit 14 comprising, e.g., a refiner or the like. Subsequently, free calcium carbonate can be washed out in a washing step 16, if necessary. As described above, such a washing step 16 can be omitted. The fibrous suspension 10 is subsequently fed to a tissue machine 18, where the desired tissue or hygiene web 20 (and the respective final tissue product) is obtained.

[0069] The exemplary embodiment shown in Fig. 2 differs from that in Fig. 1 only in that the fibrous suspension 10 first is fed to the treatment unit 14 comprising, e.g., a refiner or the like, and then to the "Fiber Loading™" process. The washing step 16 is not obligatory in this case either.

[0070] In both cases, the fibers contained in the fibrous suspension 10 are directly loaded in an online process with a filler in the tissue material preparation line by a chemical precipitation reaction. Crystalline precipitation product particles are produced in the online process. The precipitation product is preferably calcium carbonate. Calcium oxide and/or calcium hydroxide is added to the fibrous suspension to load the fibers. The precipitation is then initiated through carbon dioxide or a gas containing carbon dioxide (e.g., flue gas or the like). The crystalline precipitation product particles are produced in the respective gas atmosphere without the insertion of mixing energy. The fibrous suspension can be fed to a treatment unit 14 comprising a fluffer, a refiner, a disperger and/or the like. The fibers of the fibrous suspension 10 can be loaded with filler before or

after the treatment unit 14. The treatment unit 14 can, at the same time, act as a reactor for the chemical precipitation reaction.

List of Reference Numbers

10	Fibrous suspension
12	"Fiber Loading™" process
14	Treatment unit
16	Washing step
18	Tissue machine
20	Tissue or hygiene web